INTEGRATED CIRCUITS

DATA SHEET

TDA4851

Horizontal and vertical deflection controller for VGA/XGA and autosync monitors

Preliminary specification
File under Integrated Circuits, IC02

November 1992

Philips Semiconductors

PHILIPS

Horizontal and vertical deflection controller for VGA/XGA and autosync monitors

TDA4851

FEATURES

- VGA operation fully implemented including alignment-free vertical and E/W amplitude presettings
- 4th VGA mode easy applicable (XGA, Super VGA)
- Autosync operation externally selectable
- Low jitter
- All adjustments DC-controllable
- Alignment-free oscillators
- Sync separators for video or horizontal and vertical TTL sync levels regardless of polarity
- Horizontal oscillator with PLL1 for sync and PLL2 for flyback
- Constant vertical and E/W amplitude in autosync operation
- DC-coupling to vertical power amplifier
- Internal supply voltage stabilization with excellent ripple rejection to ensure stable geometrical adjustments

GENERAL DESCRIPTION

The TDA4851 is a monolithic integrated circuit for economical solutions in VGA/XGA and autosync monitors. The IC incorporates the complete horizontal and vertical small signal processing.
VGA-dependent mode detection and settings are performed on chip. In conjunction with TDA4860/61/65, or TDA8351 (vertical output circuits) the ICs offer an extremely advanced system solution.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V_P	positive supply voltage (pin 1)	9.2	12	16	V
I_P	supply current	–	40	–	mA
$V_{i\ sync}$	AC-coupled composite video signal with negative-going sync (peak-to-peak value, pin 9)	–	1	–	V
	sync slicing level	–	120	–	mV
	DC-coupled TTL-compatible horizontal sync signal (peak-to-peak value, pin 9)	1.7	–	–	V
	slicing level	1.2	1.4	1.6	V
	DC-coupled TTL-compatible vertical sync signal (peak-to-peak value, pin 10)	1.7	–	–	V
	slicing level	1.2	1.4	1.6	V
$I_{o\ V}$	vertical differential output current (peak-to-peak value, pins 5 and 6)	–	1	–	mA
$I_{o\ H}$	horizontal sink output current on pin 3	–	–	60	mA
T_{amb}	operating ambient temperature range	0	–	+70	°C

ORDERING INFORMATION

EXTENDED TYPE NUMBER	PACKAGE			
	PINS	PIN POSITION	MATERIAL	CODE
TDA4851	20	DIL	plastic	SOT146(1)

Note

1. SOT146-1; 1996 November 26.

Horizontal and vertical deflection controller for VGA/XGA and autosync monitors

TDA4851

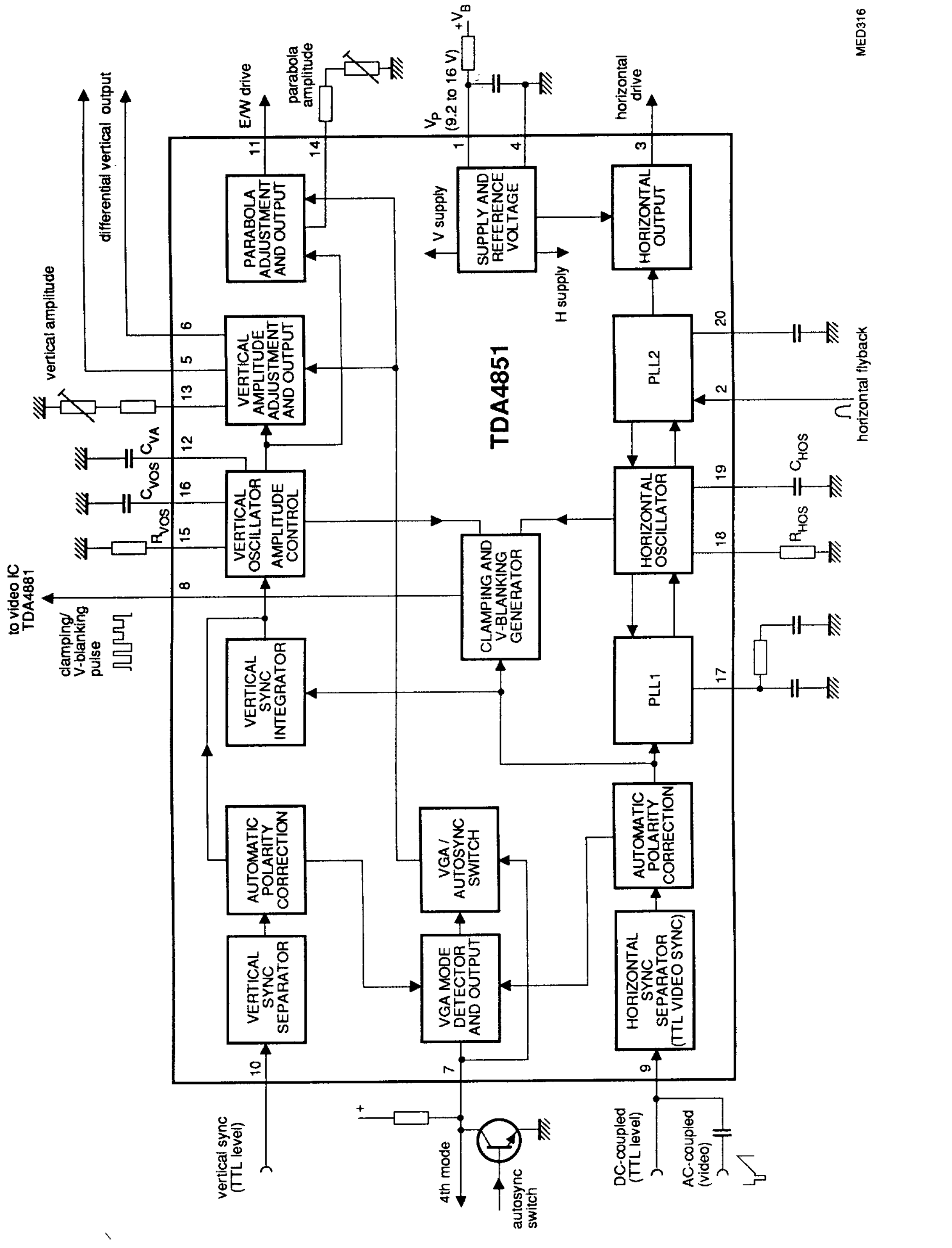


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
V_P	1	positive supply voltage
FLB	2	horizontal flyback input
HOR	3	horizontal output
GND	4	ground (0 V)
VERT1	5	vertical output 1; negative-going sawtooth
VERT2	6	vertical output 2; positive-going sawtooth
MODE	7	4th mode output and autosync input
CLBL	8	clamping/blanking pulse output
HVS	9	horizontal sync/video input
VS	10	vertical sync input
EW	11	E/W output (parabola to driver stage)
C_{VA}	12	capacitor for amplitude control
R_{VA}	13	vertical amplitude adjustment input
R_{EW}	14	E/W amplitude adjustment input (parabola)
R_{VOS}	15	vertical oscillator resistor
C_{VOS}	16	vertical oscillator capacitor
PLL1	17	PLL1 phase
R_{HOS}	18	horizontal oscillator resistor
C_{HOS}	19	horizontal oscillator capacitor
PLL2	20	PLL2 phase

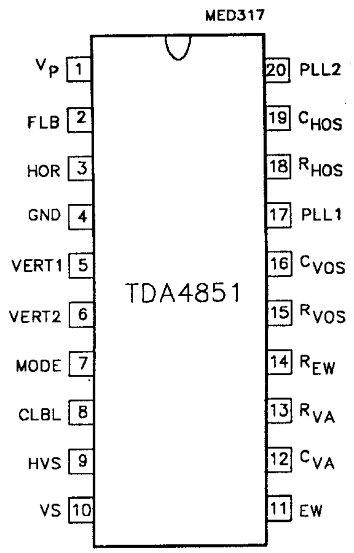


Fig.2 Pin configuration.

FUNCTIONAL DESCRIPTION

Horizontal sync separator and polarity correction

An AC-coupled video signal or a DC-coupled TTL sync signal (H only or composite sync) is input on pin 9. Video signals are clamped with top sync on 1.28 V, and are sliced at 1.4 V. This results in a fixed absolute slicing level of 120 mV related to top sync.
DC-coupled TTL sync signals are also sliced at 1.4 V, however with the clamping circuit in current limitation.
The polarity of the separated sync is detected by internal integration of the signal, then the polarity is corrected. The polarity information is fed to the VGA mode detector. The corrected sync is input signal for the vertical sync integrator and the PLL1 stage.

Vertical sync separator, polarity correction and vertical sync integrator

DC-coupled vertical TTL sync signals may be applied to pin 10. They are sliced at 1.4 V. The polarity of the separated sync is detected by internal integration, then the polarity is corrected. The polarity information is fed to the VGA mode detector. If pin 10 is not used, it must be connected to ground. The separated $V_{i\,sync}$ signal from pin10, or the integrated composite sync signal from pin 9 (TTL or video) triggers directly the vertical oscillator.

VGA mode detector and mode output

The three standard VGA modes and a 4th not fixed mode are decoded by the polarities of the horizontal and the vertical sync input signals. An external resistor (from V_P to pin 7) is necessary to match this function. In all three VGA modes the correct amplitudes are activated. The presence of the 4th mode is indicated by a HIGH on pin 7. This signal can be used externally to switch any horizontal or vertical parameters.

VGA mode detector input

For autosync operation the voltage on pin 7 must be externally forced to a level of < 50 mV. Vertical amplitude pre-settings for VGA are then inhibited. The delay time between vertical trigger pulse and the start of vertical deflection changes from 575 µs to 300 µs (575 µs is

needed for VGA). The vertical amplitude then remains constant in a frequency range from 50 Hz up to 110 Hz.

Clamping and V-blanking generator

A combined clamping and V-blanking pulse is available on pin 8 (suitable for the video pre-amplifier TDA4881). The lower level of 1.9 V is the blanking signal derived from the vertical blanking pulse from the internal vertical oscillator. Vertical blanking equals the delay between vertical sync and start of vertical scan. By this, an optimum blanking is achieved for VGA/XGA and autosync operation (selectable via pin 7).
The upper level of 5.4 V is the horizontal clamping pulse with an internally fixed pulse width of 0.8 µs. A monoflop, which is triggered by the trailing edge of the horizontal sync pulse, generates this pulse. If composite sync is applied, one clamping pulse per H-period is generated during V-sync. The phase of the clamping pulse may change during V-sync (see Fig.8).

PLL1 phase detector

The phase detector is a standard type using switched current sources. The middle of the sync is compared with a fixed point of the oscillator sawtooth voltage. The PLL filter is connected to pin 17. If composite sync is applied, the disturbed control voltage is corrected during V-sync (see Fig.8).

Horizontal oscillator

This oscillator is of the relaxation type and requires a fixed capacitor of 10 nF at pin 19. By changing the current into pin 18 the whole frequency range from 13 to 100 kHz can be covered.
The current can be generated either by a frequency to voltage converter or by a resistor. A frequency adjustment may also be added if necessary.
The PLL1 control voltage at pin 17 modulates via a buffer stage the oscillator thresholds. A high DC-loop gain ensures a stable phase relationship between horizontal sync and line flyback pulses.

PLL2 phase detector

This phase detector is similar to the PLL1 phase detector. Line flyback signals (pin 2) are compared with a fixed point of the oscillator sawtooth voltage. Delays in the horizontal deflection circuit are compensated by adjusting the phase relationship between horizontal sync and horizontal output pulses.

A certain amount of phase adjustment is possible by injecting a DC current from an external source into the PLL2 filter capacitor at pin 20.

Horizontal driver

This open-collector output stage (pin 3) can directly drive an external driver transistor. The saturation voltage is less than 300 mV at 20 mA.
To protect the line deflection transistor, the horizontal output stage does not conduct for $V_P < 6.4$ V (pin 1).

Vertical oscillator and amplitude control

This stage is designed for fast stabilization of the vertical amplitude after changes in sync conditions. The free-running frequency f_0 is determined by the values of R_{VOS} and C_{VOS}. The recommended values should be altered marginally only to preserve the excellent linearity and noise performance. The vertical drive currents I_5 and I_6 are in relation to the value of R_{VOS}.
Therefore, the oscillator frequency must be determined only by C_{VOS} on pin 16.

$$f_0 = \frac{1}{10.8 \times R_{VOS} \times C_{VOS}}$$

To achieve a stabilized amplitude the free-running frequency f_0 (without adjustment) must be lower than the lowest occurring sync frequency. The following contributions can be assumed:

minimum frequency offset between f_0 and the lowest trigger frequency	10%
spread of IC	±3%
spread of R (22 kΩ)	±1%
spread of C (0.1 µF)	±5%
	19%

$$\text{Result: } f_0 = \frac{50}{1.19}\text{ Hz} = 42\text{ Hz}$$

(for 50 to 110 Hz application)

Table 1 VGA modes

MODE	H / V SYNC POLARITY	FREQUENCY H (kHz)	FREQUENCY V (Hz)	NUMBER OF ACTIVE LINES	MODE OUTPUT PIN 7
1	+ / –	31.45	70	350	LOW
2	– / +	31.45	70	400	LOW
3	– / –	31.45	60	480	LOW
4	+ / +	fixed by external circuitry	–	–	HIGH
autosync	*/*	fixed by external circuitry	–	–	forced to GND

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134)

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
V_P	supply voltage (pin 1)	–0.5	16	V
$V_{3,7}$	voltage on pins 3 and 7	–0.5	16	V
V_8	voltage on pin 8	–0.5	7	V
V_n	voltage on pins 5, 6, 9, 10, 13, 14 and 18	–0.5	6.5	V
I_2	current on pin 2	–	±10	mA
I_3	current on pin 3	–	100	mA
I_7	current on pin 7	–	20	mA
I_8	current on pin 8	–	–10	mA
T_{stg}	storage temperature range	–55	+150	°C
T_{amb}	operating ambient temperature range	0	70	°C
Tj	maximum junction temperature	0	+150	°C
V_{ESD}	electrostatic handling for all pins (note 1)	–	±400	V

Note to the Limiting Values

1. Equivalent to discharging a 200 pF capacitor through a 0 Ω series resistor.

THERMAL RESISTANCE

SYMBOL	PARAMETER	THERMAL RESISTANCE
$R_{th\ j\text{-}a}$	from junction to ambient in free air	65 K/W

CHARACTERISTICS

V_P = 12 V; T_{amb} = +25 °C; measurements taken in Fig.3 unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_P	positive supply voltage (pin 1)		9.2	12	16	V
I_P	supply current	I_{18} = –1.05 mA	–	36	44	mA
		I_{18} = –3.388 mA	–	40	49	mA
Internal reference voltage						
V_{ref}	internal reference voltage		6.0	6.25	6.5	V
TC	temperature coefficient	T_{amb} = +20 to +100 °C	–	–	±90	10^{-6}/K
PSRR	power supply ripple rejection	f = 1 kHz sinewave	60	75	–	dB
		f = 1 MHz sinewave	25	35	–	dB
V_P	supply voltage (pin 1) to ensure all internal reference voltages		9.2	–	16	V
Composite sync input (AC-coupled)		V_{10} = 5 V				
$V_{i\ sync}$	sync amplitude of video input signal (pin 9)	sync on green	–	300	–	mV
	top sync clamping level		1.1	1.28	1.5	V
	slicing level above top sync level	R_S = 50 Ω	90	120	150	mV
R_S	allowed source resistance for 7% duty factor	$V_{i\ sync}$ > 200 mV	–	–	1.5	kΩ
r_9	differential input resistance	during sync	–	80	–	Ω
I_9	charging current of coupling capacitor	V_9 > 1.5 V	1.3	2	3	μA
t_{int}	vertical sync integration time to generate vertical trigger pulse	f_H = 31 kHz; I_{18} = –1.050 mA	7	10	13	μs
		f_H = 64 kHz; I_{18} = –2.169 mA	3.5	5	6.5	μs
		f_H = 100 kHz; I_{18} = –3.388 mA	2.5	3.4	4.5	μs
Horizontal sync input (DC-coupled, TTL-compatible)						
$V_{i\ sync}$	sync input signal (peak-to-peak value, pin 9)		1.7	–	–	V
	slicing level		1.2	1.4	1.6	V
t_p	minimum pulse width		700	–	–	ns
t_r, t_f	rise time and fall time		10	–	500	ns
I_9	input current	V_9 = 0.8 V	–	–	–200	μA
		V_9 = 5.5 V	–	–	10	μA
Automatic horizontal polarity switch		H-sync on pin 9				
$t_{p\ H}/t_H$	horizontal sync pulse width related to t_H (duty factor for automatic polarity correction)		–	–	30	%
t_p	delay time for changing sync polarity		0.3	–	1.8	ms

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Vertical sync input (DC-coupled, TTL-compatible)		V-sync on pin 10				
$V_{i\ sync}$	sync input signal (peak-to-peak value, pin 10)		1.7	–	–	V
	slicing level		1.2	1.4	1.6	V
I_{10}	input current	$0 < V_{10} < 5.5$ V	–	–	±10	μA
$t_{p\ V}$	maximum vertical sync pulse width for automatic vertical polarity switch		–	–	300	μs
Horizontal mode detector output		VGA mode				
V_7	output saturation voltage LOW (for Modes 1, 2 and 3)	$I_7 = 6$ mA	–	0.275	0.33	V
	output voltage HIGH	mode 4	–	–	V_P	V
I_7	load current range to force VGA mode-dependent vertical and parabola amplitudes	modes 1, 2 and 3	2	–	6	mA
	output current	mode 4	–	0	–	mA
VGA / autosync mode switch						
V_7	input voltage LOW to force autosync mode		0	–	50	mV
Horizontal clamping / blanking generator output		Fig.6				
V_8	output voltage LOW		–	–	0.9	V
	blanking output voltage	internal V blanking	1.6	1.9	2.2	V
	clamping output voltage	H-sync on pin 9	5.15	5.4	5.65	V
I_8	internal sink current for all output levels	H and V scanning	2.3	2.9	3.5	mA
	external load current		–	–	–3.0	mA
t_8	clamping pulse start		with end of H-sync			
t_{clp}	clamping pulse width	$V_8 = 3$ V	0.6	0.8	1.0	μs
S	steepness of rise and fall times		–	60	75	ns/V
Vertical oscillator		$V_{ref} = 6.25$ V				
f_0	vertical free-running frequency	$R_{15} = 22$ kΩ; $C_{16} = 0.1$ μF	–	42	–	Hz
f_v	nominal vertical sync range	no f_0 adjustment	50	–	110	Hz
V_{15}	voltage on pin 15	$R_{15} = 22$ kΩ	2.8	3.0	3.2	V
t_d	delay between sync pulse and start of vertical scan	measured on pin 8				
	in VGA/XGA mode, activated by an external resistor on pin 7		500	575	650	μs
	in autosync mode	$V_7 < 50$ mV	240	300	360	μs
I_{12}	control current for amplitude control		–	±200	–	μA
C_{12}	capacitor for amplitude control		–	–	0.18	μF

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Vertical differential output		Fig.7				
I_o	differential output current between pins 5 and 6 (peak-to-peak value)	mode 3; I_{13} > –135 μA; R_{15} = 22 kΩ	0.9	1.0	1.1	mA
	maximum offset-current error	I_o = 1 mA	–	–	±2.5	%
	maximum linearity error		–	–	±1.5	%
Vertical amplitude adjustment (in percentage of output signal)						
V_{13}	input voltage		–	5.0	–	V
I_{13}	adjustment current	$I_{o\ max}$ (100%)	–110	–120	–135	μA
		$I_{o\ min}$ (typically 58%)	–	0	–	μA
$\Delta I_o/\Delta t$	VGA mode-dependent pre-settings activated by an external resistor on pin 7	Table 1; note 1				
	Mode 1		116.2	116.8	117.4	%
	Mode 2		101.6	102.2	102.8	%
	Mode 3		–	100	–	%
	Mode 4		–	100	–	%
	autosync operation (VGA operation disabled)	V_7 < 50 mV	–	100	–	%
Horizontal comparator PLL1						
V_{17}	upper control voltage limitation		–	5.9	–	V
	lower control voltage limitation		–	5.1	–	V
I_{17}	control current	Fig.6	–	±0.083I_{18}	–	mA
Horizontal oscillator						
f_{osc}	centre frequency	R_{18} = 2.4 kΩ (pin 18); C_{19} = 10 nF (pin 19)	–	31.45	–	kHz
	deviation of centre frequency		–	–	±3	%
	temperature coefficient		0	+200	+300	10^{-6}/K
φ_H/t_H	relative holding/catching range		±6	±6.5	±7.3	%
I_{18}	external oscillator current		–0.5	–	–4.3	mA
V_{18}	voltage at reference current input (pin 18)		2.35	2.5	2.65	V
Horizontal PLL2		Fig.6				
V_2	upper clamping level of flyback input	I_2 = 6 mA	–	5.5	–	V
	lower clamping level of flyback input	I_2 = –1 mA	–	–0.75	–	V
	H-flyback slicing level		–	3.0	–	V
t_d/t_H	delay between middle of sync and middle of H-flyback related to t_H		–	3.0	–	%
V_{20}	upper control voltage limitation		–	6.2	–	V
	lower control voltage limitation		–	4.8	–	V
I_{20}	control current		–	±0.083I_{18}	–	μA
$\Delta t/t_H$	PLL2 control range related to t_H		30	–	–	%

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Horizontal output (open-collector)		Fig.6				
V_3	output voltage LOW	I_3 = 20 mA	–	–	0.3	V
		I_3 = 60 mA	–	–	0.8	V
t_p/t_H	t_H duty factor		42	45	48	%
V_P	threshold to activate under voltage protection	horizontal output off	–	5.6	–	V
		horizontal output on	–	5.8	–	V
Δt_H	jitter of horizontal output	f = 31 kHz	–	–	3.5	ns
		f = 64 kHz	–	–	1.9	ns
		f = 100 kHz	–	–	1.2	ns
E/W output		note 2				
V_{11}	bottom output signal during mid-scan (pin 11)	internally stabilized	1.05	1.2	1.35	V
	top output signal during flyback		4.2	4.5	4.8	V
	temperature coefficient of output signal		–	–	250	10^{-6}/K
E/W amplitude adjustment (parabola)		Fig.7				
V_{14}	input voltage (pin 14)		–	5.0	–	V
I_{14}	adjustment current	100% parabola	–110	–120	–135	µA
		typically 28% parabola	–	0	–	µA

Notes to the characteristics

1. $\Delta I_o/\Delta t$ relative to value of Mode 3.
2. Parabola amplitude tracks with mode-dependent vertical amplitude but not with vertical amplitude adjustment. Tracking can be achieved by a resistor from vertical amplitude potentiometer to pin 14.

APPLICATION INFORMATION

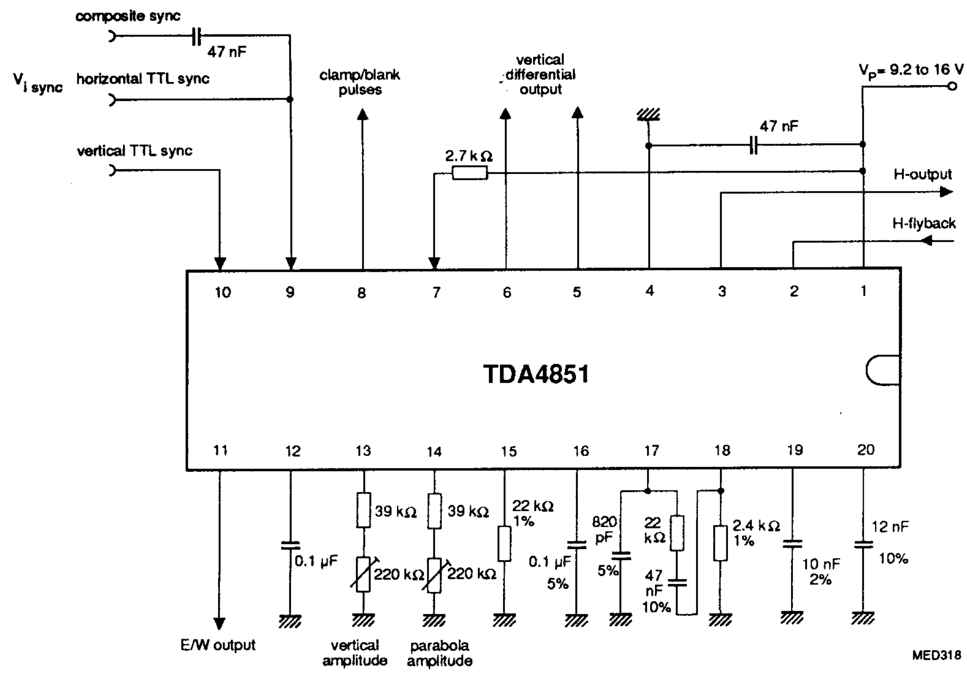


Fig.3 Application circuit for 3-mode VGA (31.45 kHz).

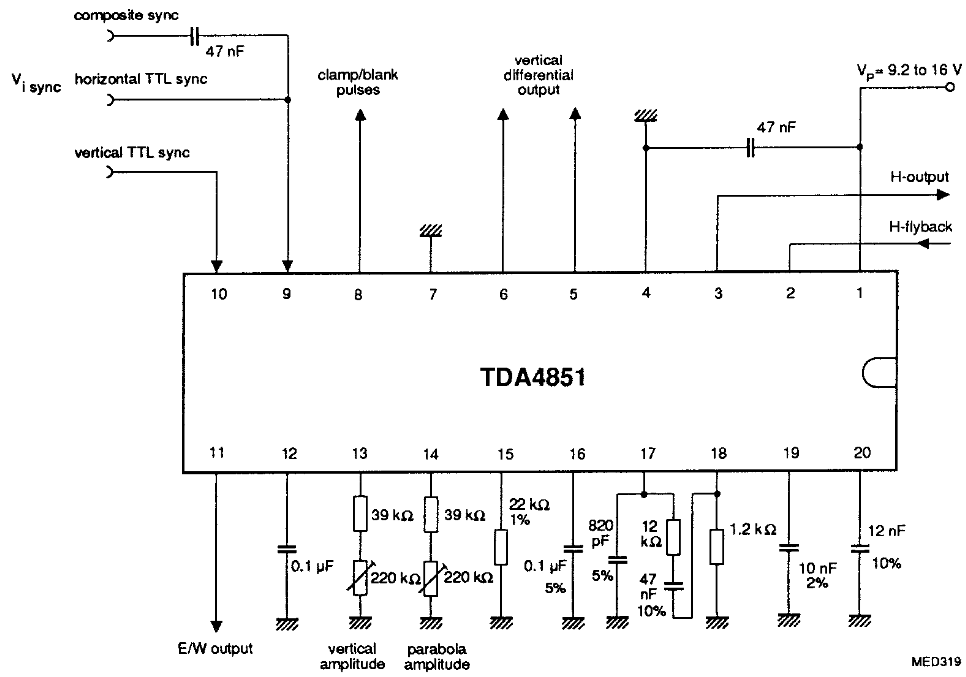


Fig.4 64 kHz application circuit.

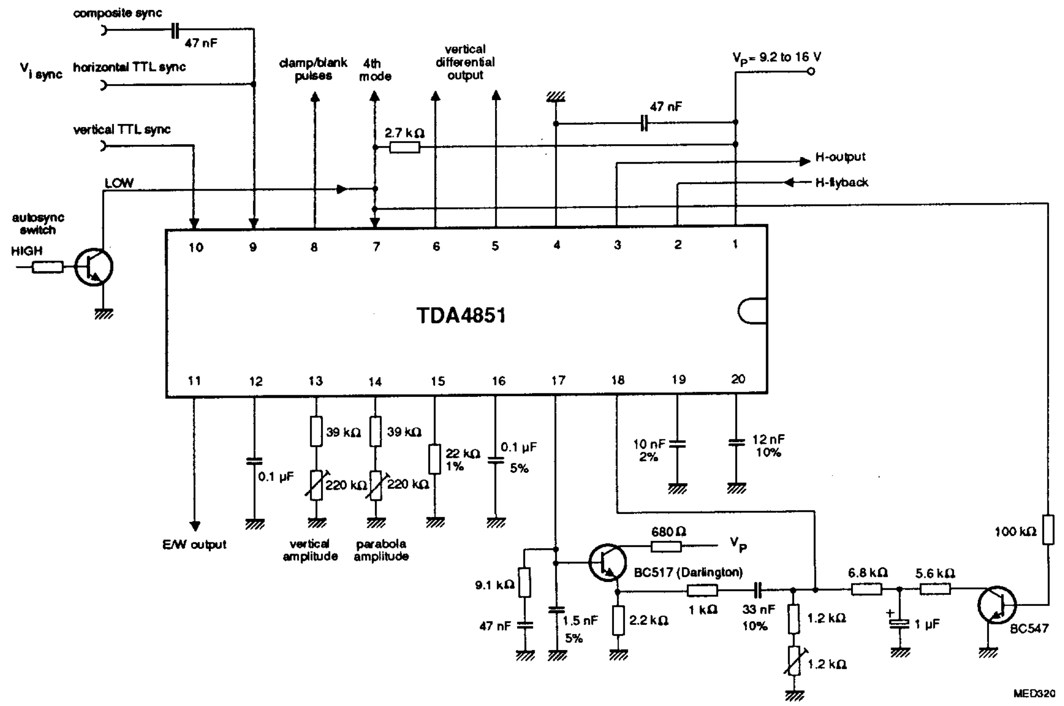


Fig.5 31 to 64 kHz application including 4-mode VGA.

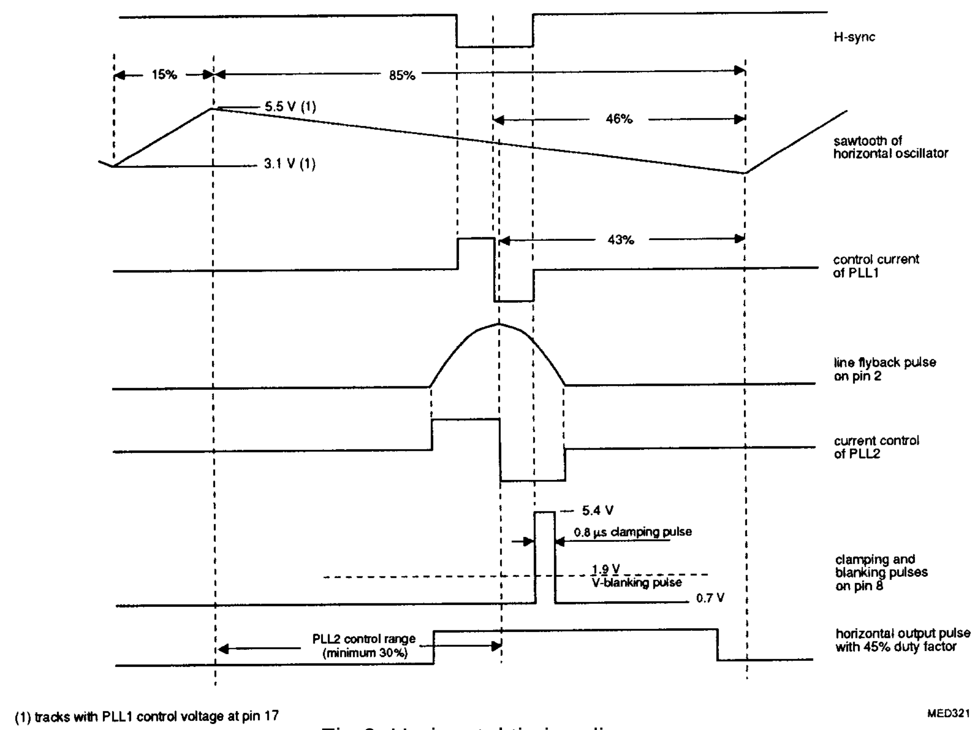


Fig.6 Horizontal timing diagram.

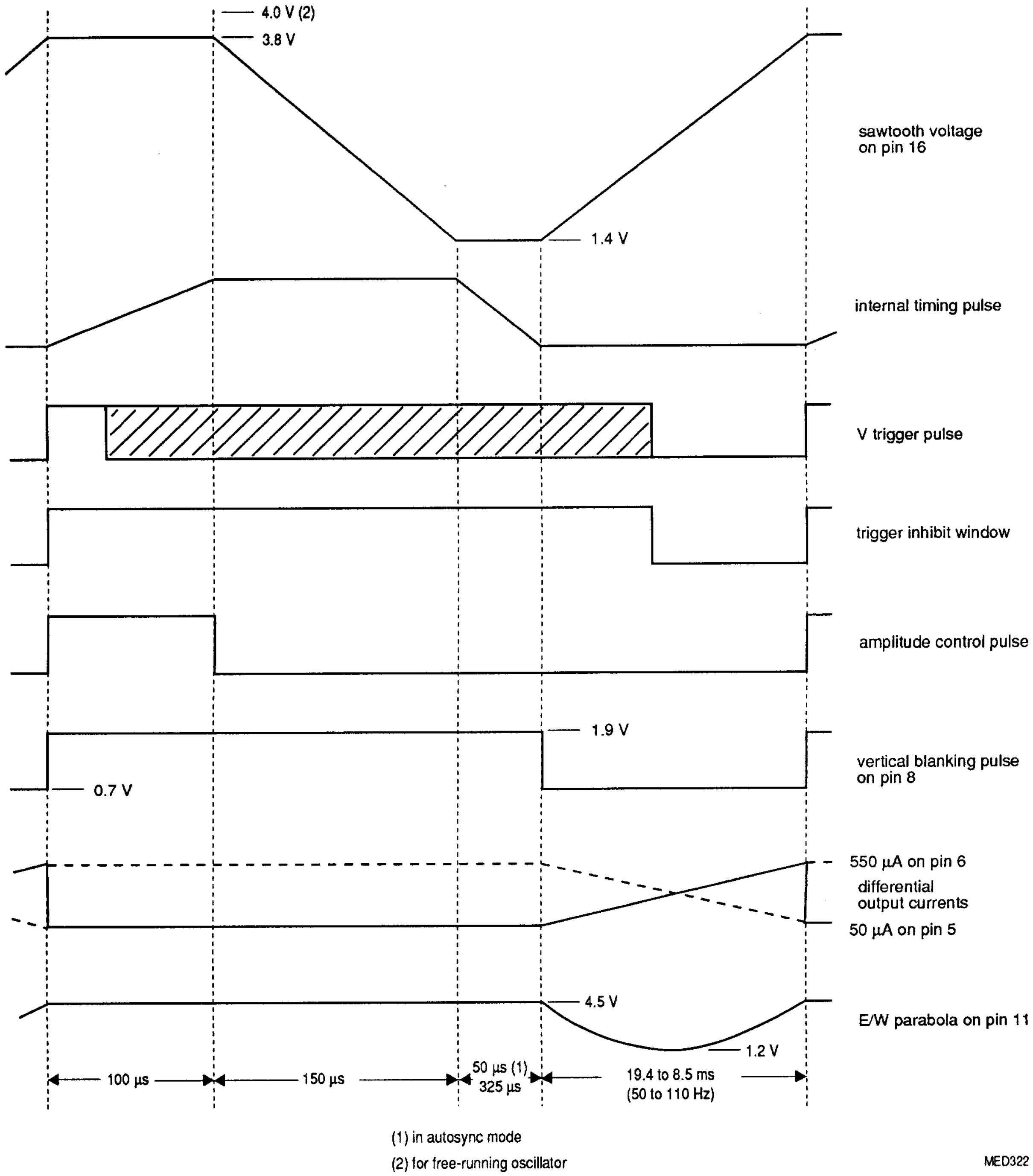
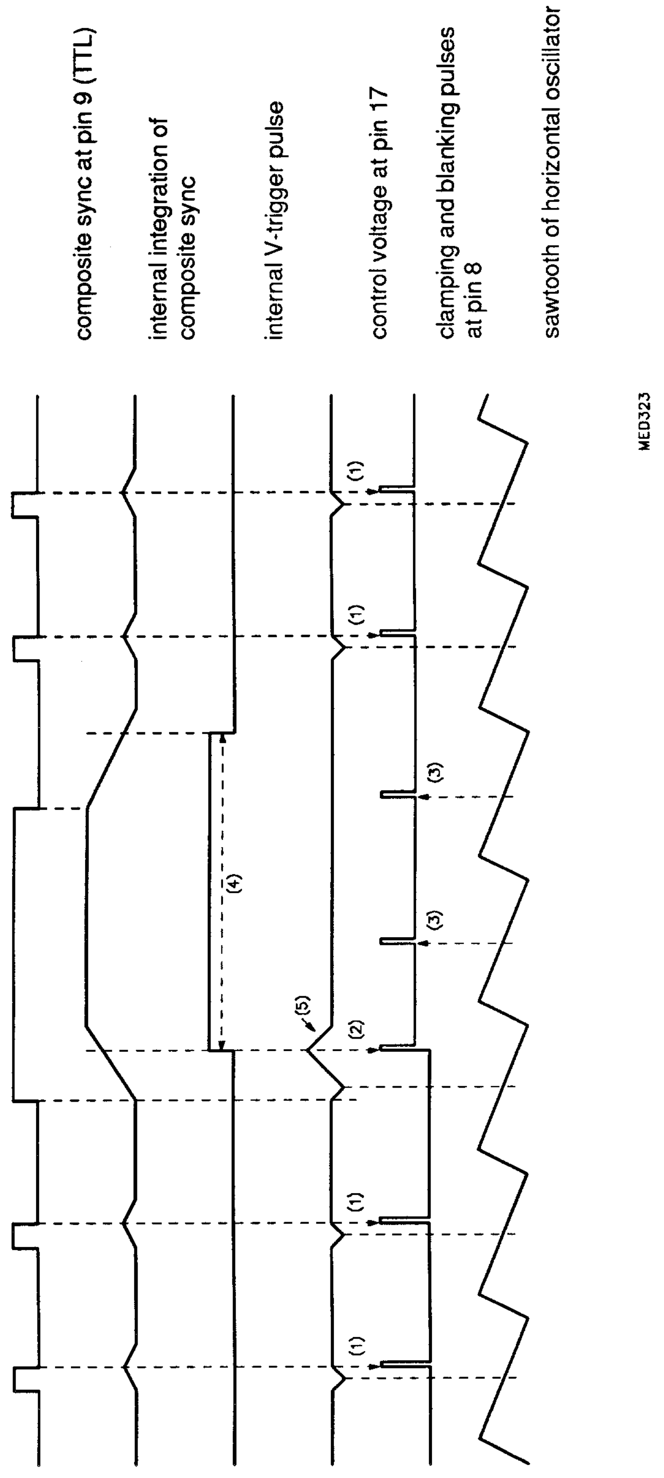


Fig.7 Vertical and E/W timing diagram.



(1) clamp pulses triggered by H-sync
(2) clamp pulses triggered by leading edge of V-trigger pulse
(3) clamp pulses triggered by horizontal oscillator
(4) during V-trigger pulse clamp pulses are generated internally
(5) control voltage of PLL1 is corrected during V-trigger pulse

Fig.8 Pulse diagram for composite sync applications (showing reduced influence of V-sync on H-phase and drive pulses for F/V converters).

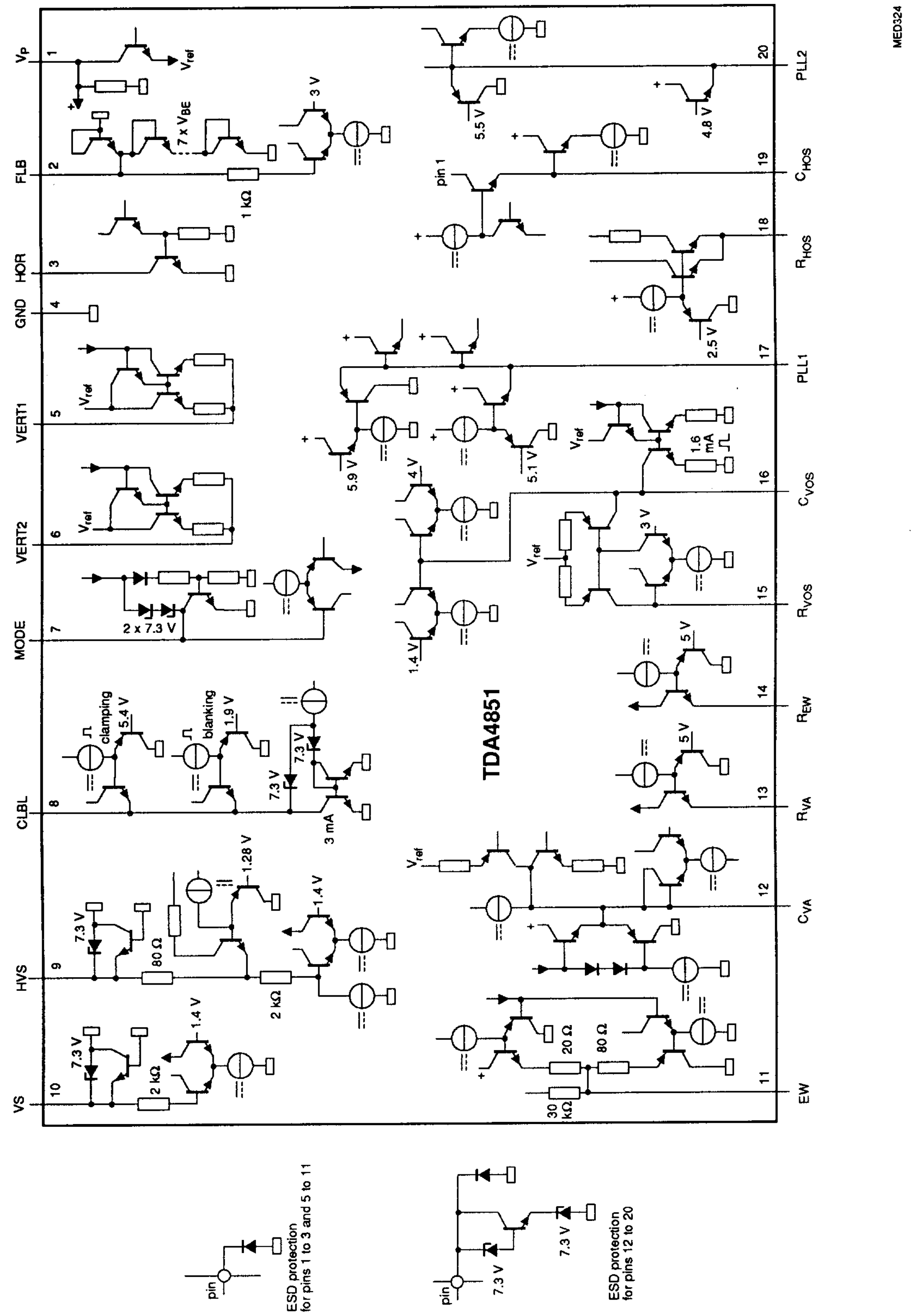
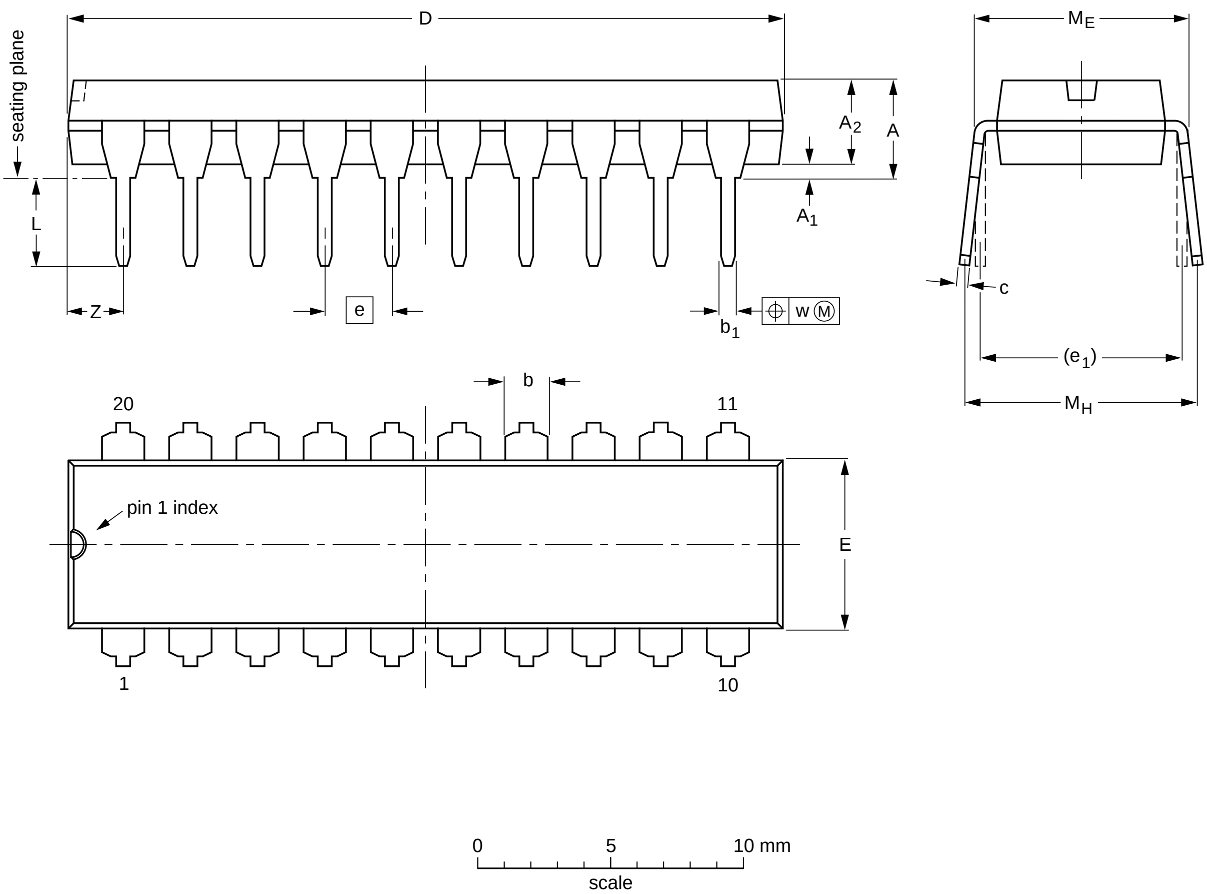


Fig.9 Internal circuits.

PACKAGE OUTLINE

DIP20: plastic dual in-line package; 20 leads (300 mil) **SOT146-1**



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A_1 min.	A_2 max.	b	b_1	c	D [(1)]	E [(1)]	e	e_1	L	M_E	M_H	w	Z [(1)] max.
mm	4.2	0.51	3.2	1.73 1.30	0.53 0.38	0.36 0.23	26.92 26.54	6.40 6.22	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	2.0
inches	0.17	0.020	0.13	0.068 0.051	0.021 0.015	0.014 0.009	1.060 1.045	0.25 0.24	0.10	0.30	0.14 0.12	0.32 0.31	0.39 0.33	0.01	0.078

Note

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT146-1			SC603			~~92-11-17~~ 95-05-24

SOLDERING

Introduction

There is no soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and surface mounted components are mixed on one printed-circuit board. However, wave soldering is not always suitable for surface mounted ICs, or for printed-circuits with high population densities. In these situations reflow soldering is often used.

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"IC Package Databook"* (order code 9398 652 90011).

Soldering by dipping or by wave

The maximum permissible temperature of the solder is 260 °C; solder at this temperature must not be in contact with the joint for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.

The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified maximum storage temperature ($T_{stg\ max}$). If the printed-circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

Repairing soldered joints

Apply a low voltage soldering iron (less than 24 V) to the lead(s) of the package, below the seating plane or not more than 2 mm above it. If the temperature of the soldering iron bit is less than 300 °C it may remain in contact for up to 10 seconds. If the bit temperature is between 300 and 400 °C, contact may be up to 5 seconds.

DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.